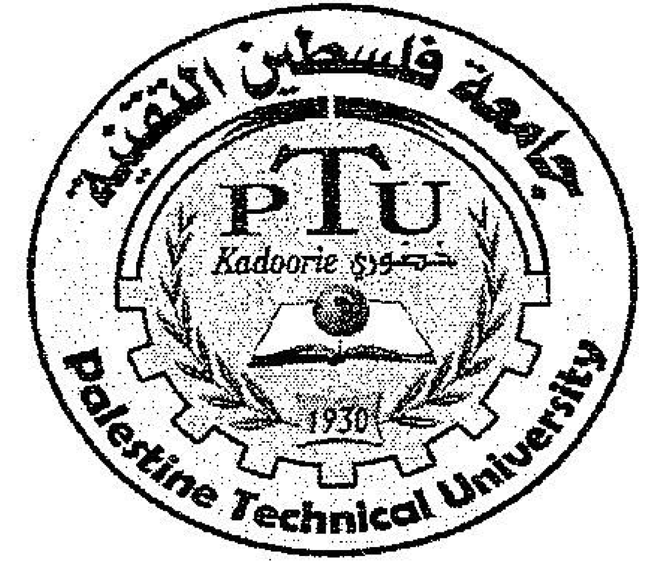
88/100

Statics Second



STATICS — اسم المساق :

12 December 2010 — تاريخ الامتحان :

57/65

11.00-11.50 — زمن الامتحان :

الامتحانات الفصلية الثانية

50 minutes

الاسم: معن سلام قعدان

التخصص: (ميكاترونيكس - كهرباء)

INSTRUCTIONS TO CANDIDATES

Read the questions carefully and

Answer **QA1 and QA2 and only ONE question from section B**.

To get a full mark, you need to show **all** work out clearly in all cases

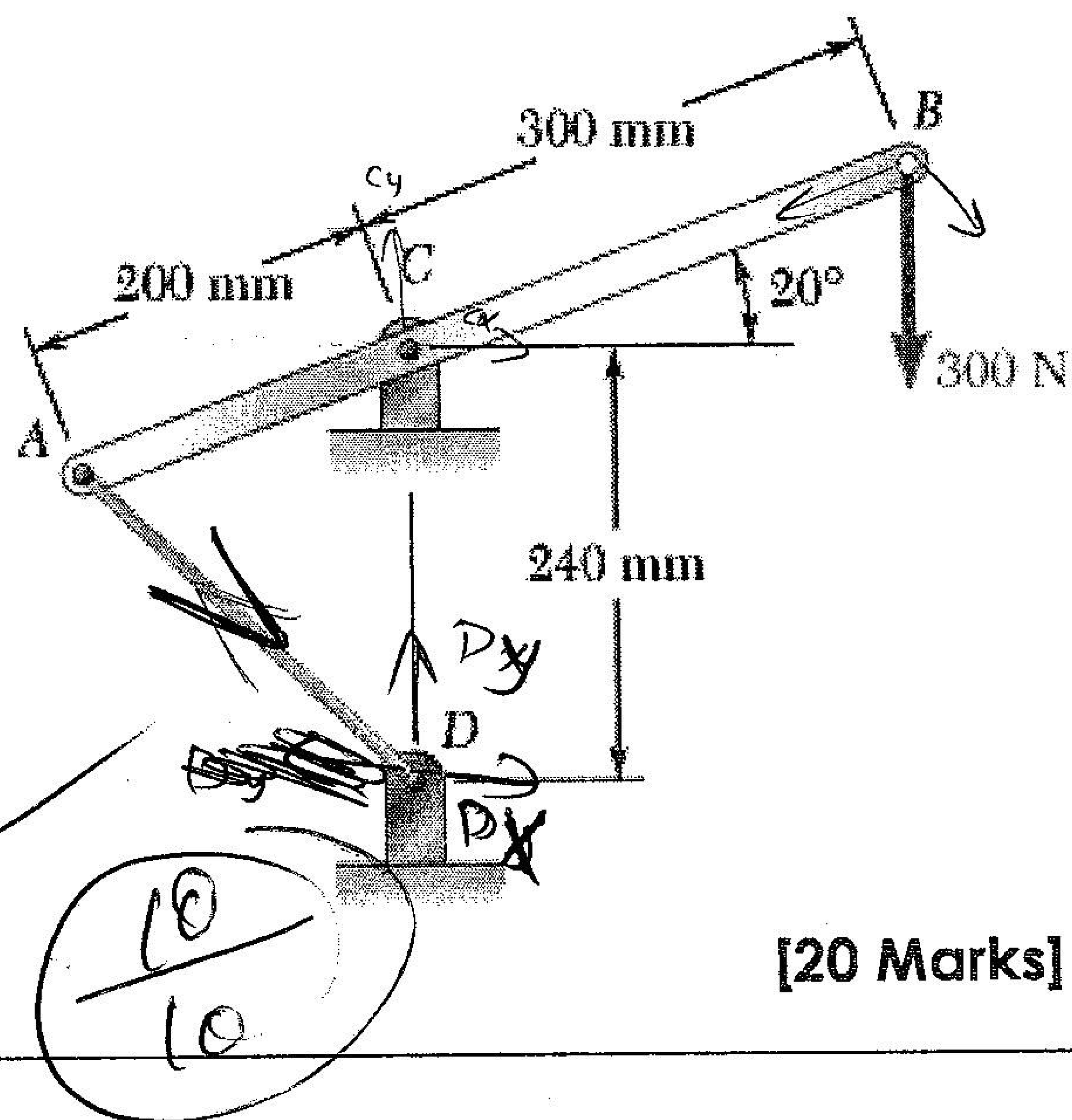
You may use a scientific calculator

تم الرفع بواسطة م. معن أبو عيسى

Section A – Answer BOTH questions in this section

QA1

A rigid lever *AB* is hinged at C and is attached to a control cable at *A*. If the lever is subjected to a 300-N vertical force at *B*, determine:



a) The tension in the cable,
b) The reaction at C.

Choose one of the following answers:

1. T = 47 N, C = 71 N @ 63.5° with Horiz.
2. T = 47.7 N, C = 71.5 N @ 61.5° with Horiz.
3. T = 477 N, C = 715 N @ 60.5° with Horiz.
4. T = 677 N, C = 7105 N @ 67.5° with Horiz.
5. T = 477 N, C = 715 N @ 64.5° with Horiz.

10/10

[20 Marks]

Ans.

~~$\Sigma M_C = 0$~~

~~$-300(300 \sin 20)$~~

~~$\Sigma M_D = 0$~~ $\Sigma M_C = 0$

$-300(300 \cos 20) + A(200 \cos 20) = 0$

$-84572.3 + 187.9A \Rightarrow A = \frac{+84572.3}{+187} = 452\ N$ → 477 N

??

~~$\Sigma M_D = 0$~~

~~$-300(300 \cos 20) +$~~

2/10

$C = \sqrt{(C_x)^2 + (C_y)^2} =$

$\phi = \tan^{-1}\left(\frac{C_y}{C_x}\right) \Rightarrow \tan^{-1}\left(\frac{300}{C_x}\right) = 60.5°$

$1.76 = \frac{300}{C_x} = C_x = 170$

$C_x = 170\ N$

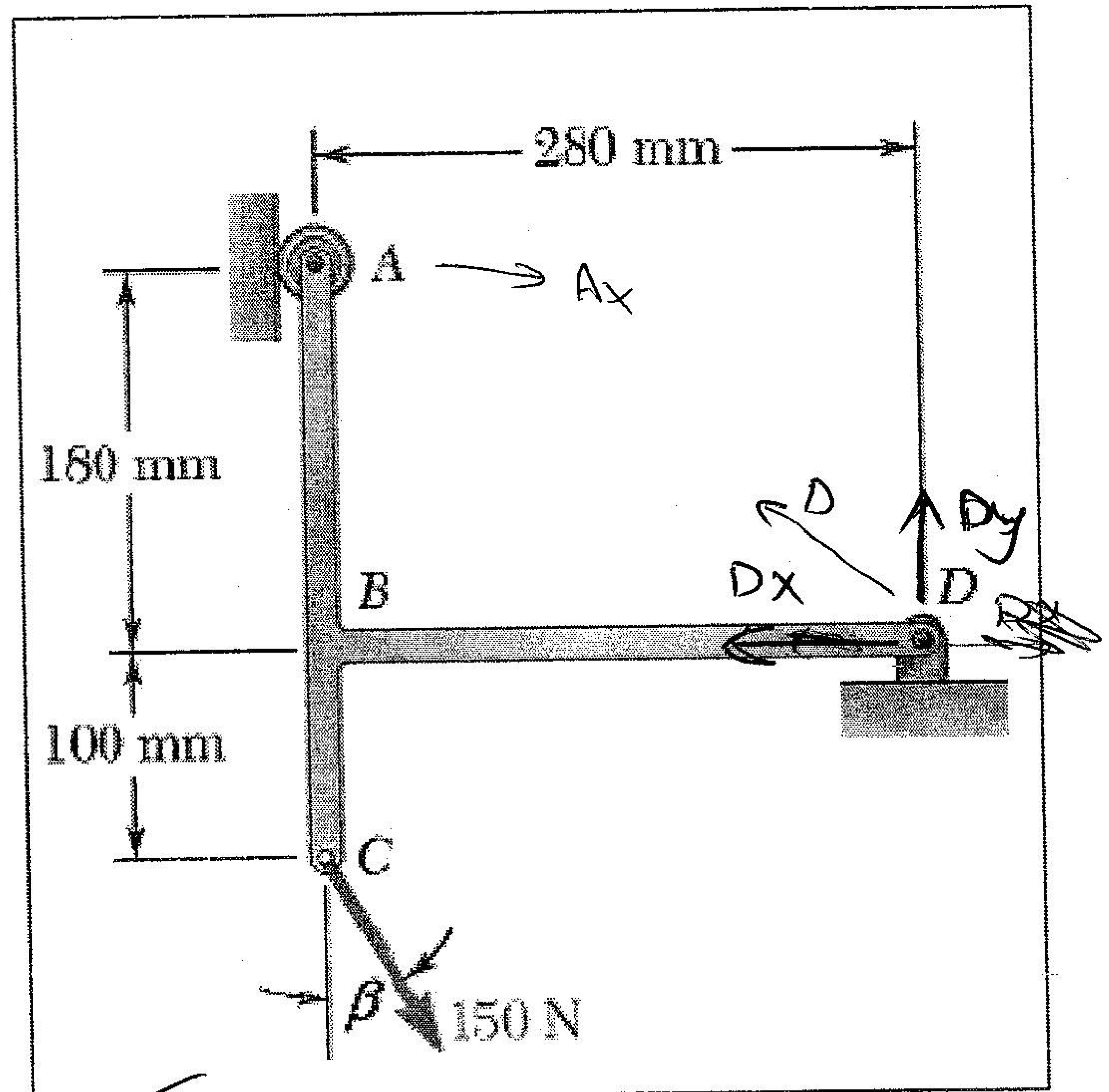
$C_y = 300\ N$??

??

Page 2

QA2

A rigid structure ABCD is supported by a pin joint at end D while end A is attached to a roller which is resting against a rigid wall as shown. In equilibrium position, ABC is held vertical while BC is horizontal. The structure is subjected to a force of 150 N at end C, making an angle of 25° with the vertical.



For this structure, determine (a) the reaction at A (b) the reaction at D

Choose one of the following options:

1. A = 244.7 N →, D = 344 @ 22.6°
2. A = 246.7 N ←, D = 344 @ 23.2°
3. A = 246.7 N →, D = 338.6 @ 23.6°
4. A = 244 N →, D = 344.6 @ 22.2°
5. A = 244 N →, D = 344.5 @ 22.4°

10/10

[20 marks]

Ans.

(1) $\Sigma F_x = 0$

$A_x + 150 \sin 25° + D_x = 0$

10/10

(2) $\Sigma F_y = 0$

$-150 \cos 25 + D_y = 0 \Rightarrow$

$+150 \cos 25 = +D_y \Rightarrow D_y = 150 \cos 25 \approx 136\ N$

(3) $\Sigma M_D = 0 \Rightarrow$ ~~$A(180) + 150 \sin 25°$~~ $+ 150 \cos 25 = 0$

$-A(180) + 150 \sin 25°(100) + 150 \cos 25°(280) = 0$

~~$-280A + 6339.27 + 13594.61 = 0$~~

$-180A + 6339.27 + 38064.92 = 0$

$-180A + 44404.19 \Rightarrow A = \frac{44404.19}{180} = 246.7\ N \rightarrow$

$\therefore 246.7 + 63.39 + D_x = 0 \Rightarrow D_x = 310.1\ N$

$D = \sqrt{D_x + D_y} = \sqrt{(310.1)^2 + (136)^2} = 338.6\ N$

$\phi = \tan^{-1}\left(\frac{D_y}{D_x}\right) = \tan^{-1}\left(\frac{136}{310.1}\right) = \tan^{-1}(0.4385) = 23.6°$

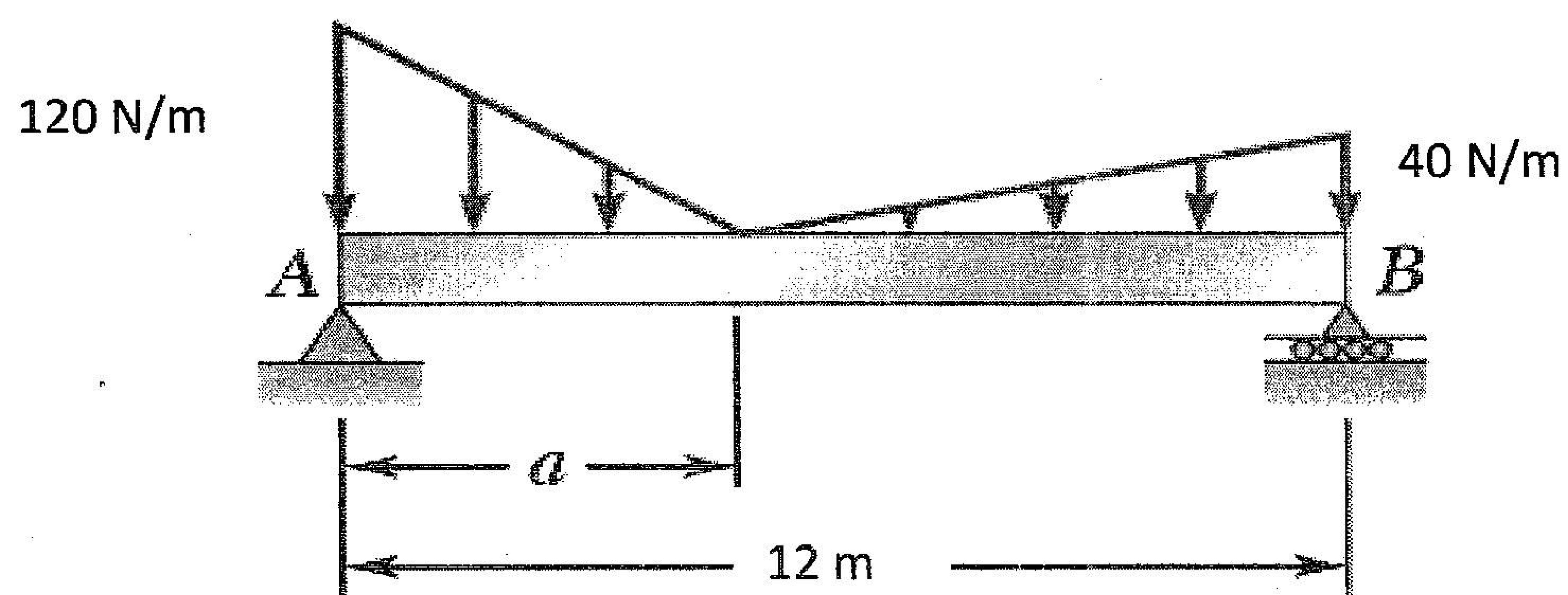
Section B – Answer ONE question only

QB1

A rigid slender beam AB is horizontally supported at A with a pin joint while B is simply supported with a roller as shown in the diagram below. The beam is subjected to distributed loading as shown. If the beam is in equilibrium and is assumed to have a negligible mass, determine:

(*a*) The distance *a* so that the vertical reactions at supports *A* and *B* are equal, **[15 Marks]**

(*b*) The corresponding reactions at the supports. **[10 Marks]**



X

Ans.

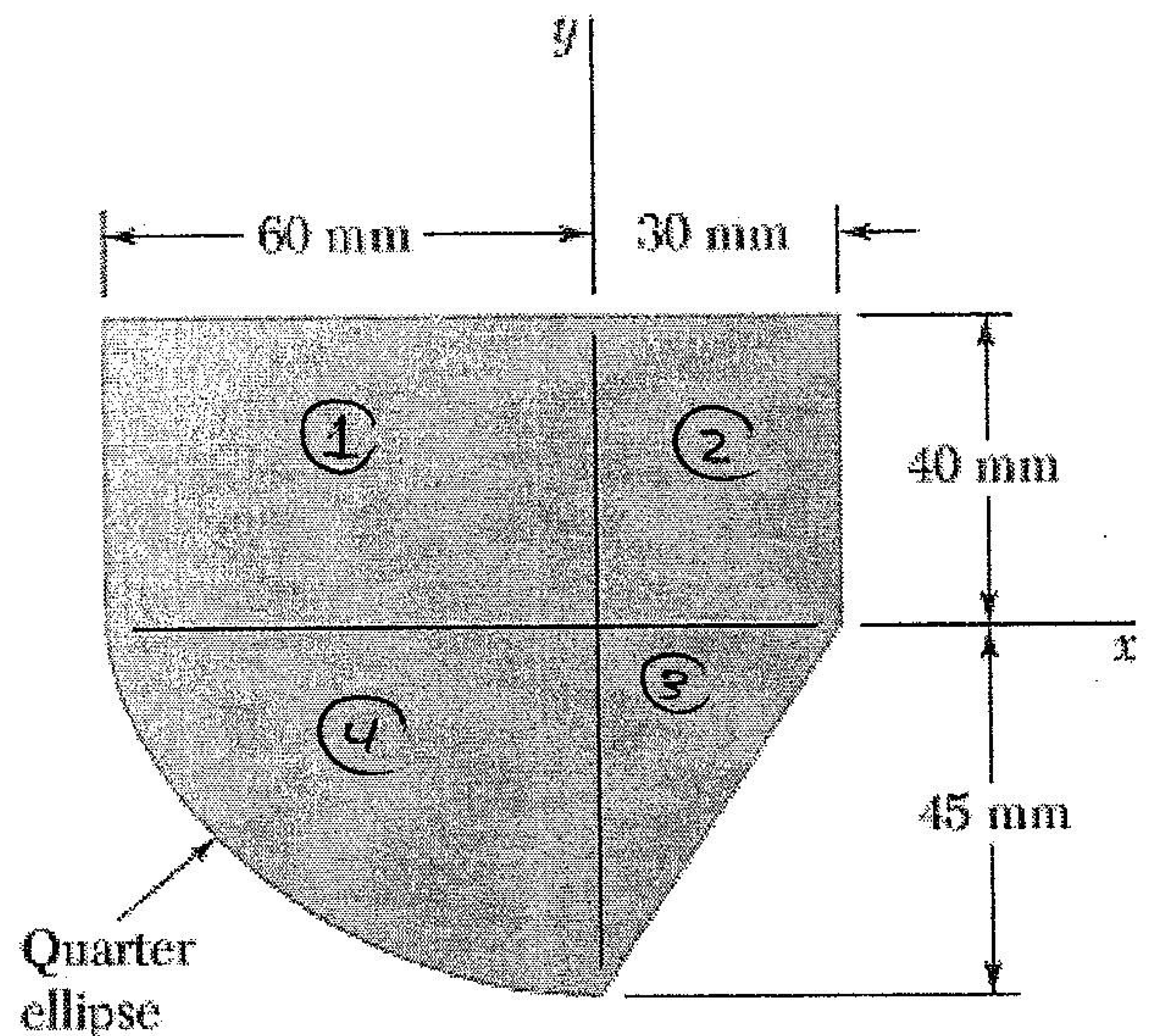
QB2

A homogeneous metal plate shaped as shown in the diagram below. If the x –y axes are set on the plate as shown, Determine (in mm):

(a) The X coordinate of the centroid of plate **[13 Marks]**

(b) The Y coordinate of the centroid of the plate **[12 Marks]**

[Hint: You may use the appropriate information given on the table given to you]



Ans.

shape	Area (mm^2)	$\bar{x}$ (mm)	$\bar{y}$ (mm)	$\bar{x}A$ (mm^3)	$\bar{y}A$ (mm^3)
rectangle # ①	2400 (60×40)	−30	20	−72000	48000
rectangle # ②	1200 (30×40)	15	20	18000	24000
triangle # ③	675 ($\frac{1}{2}$×45×30)	10	−15	6750	−10125
Quarter ellipse # ④	$\frac{\pi ab}{4} = \frac{\pi(60)(45)}{4}$ = 2120.5	$\frac{4a}{3\pi} = \frac{4(60)}{3\pi}$ = 25.46	$\frac{4b}{3\pi} = \frac{4(45)}{3\pi}$ = −19.09	~~−53975.2~~ −53987.9	−40480.3
Σ ⇒	ΣA = 6395.5			$\Sigma\bar{x}A$ = −101237.9	$\Sigma\bar{y}A$ = 21394.7

(*) ~~$\bar{X}A = \Sigma\bar{x}A$~~ $\bar{X}\Sigma A = \Sigma\bar{x}A$

~~$\Rightarrow \bar{x} =$~~ $\Rightarrow \bar{X} = \frac{\Sigma\bar{x}A}{\Sigma A} = \frac{-101237.9}{6395.5}$

$= \boxed{-15.83 \text{ mm}}$

25/25

(*) $\bar{Y}\Sigma A = \Sigma\bar{y}A$

$\Rightarrow \bar{Y} = \frac{\Sigma\bar{y}A}{\Sigma A} = \frac{21394.7}{6395.5} = \boxed{3.345 \text{ mm}}$

Information Sheet – to go with Static Test 2

Shape		$\bar{x}$	$\bar{y}$	Area
Triangular area			$\frac{h}{3}$	$\frac{bh}{2}$
Quarter-circular area		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{4}$
Semicircular area		0	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$
Quarter-elliptical area		$\frac{4a}{3\pi}$	$\frac{4b}{3\pi}$	$\frac{\pi ab}{4}$
Semielliptical area		0	$\frac{4b}{3\pi}$	$\frac{\pi ab}{2}$
Semiparabolic area		$\frac{3a}{8}$	$\frac{3h}{5}$	$\frac{2ah}{3}$
Parabolic area		0	$\frac{3h}{5}$	$\frac{4ah}{3}$
Parabolic spandrel		$\frac{3a}{4}$	$\frac{3h}{10}$	$\frac{ah}{3}$
General spandrel		$\frac{n+1}{n+2}a$	$\frac{n+1}{4n+2}h$	$\frac{ah}{n+1}$
Circular sector		$\frac{2r \sin \alpha}{3\alpha}$	0	αr^2